

Rockhopper Penguins *Eudyptes chrysocome* at Gough Island

by A. J. Williams

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The Rockhopper Penguin *Eudyptes chrysocome* is the only penguin which breeds at Gough Island (40°S, 10°W) in the South Atlantic. It is also the only species of penguin which breeds at the Tristan da Cunha Island group (c. 37°S, 12°W, Tristan for convenience), 370 km to the northwest, which is the type locality for the race *E. c. moseleyi*. The nearest breeding localities to the south of Gough Island are the Falkland Islands (51°S, 59°W) and the Prince Edward Islands (46°S, 37°E), where the populations both belong to the nominate race. Accounts of the Rockhopper Penguin at Gough and Tristan are scattered and fragmentary and contain little data. During a visit to Gough Island, from 30 October to 11 November 1979, I collected information on the size and appearance of breeding Rockhopper Penguins, estimated the total population size, and made observations on their breeding biology.

THE SUBSPECIES AT GOUGH ISLAND.

Rockhopper Penguins at Gough and Tristan were considered by early writers, most of whom had experience of several populations of the species, to be larger with longer head plumes than more southerly populations (see review in Murphy 1936). Mathews & Iredale (1921) classified birds at Tristan as a subspecies *E. c. moseleyi*, whereas Hagen (1952) concluded that they were not distinct in size or in the length of their head plumes from other populations. However, it should be noted that Hagen's own data were from birds which were at the islands for their annual moult and were not necessarily mature, breeding individuals. Elliott (1957) considered that the Rockhopper Penguins at Tristan were definitely subspecies on the basis of measurements of the birds' head plumes and of their underwing pattern. Carins (1974), on the basis of photographs, considered that Rockhopper Penguins at Gough Island belonged to the nominate race because they were "dark-faced", with the skin of the face "dark to the edge of the bill", whereas those at Tristan he considered to belong to the race *moseleyi* on the basis of "visually distinct . . . characteristics of the crest", though these surprisingly were not described.

I examined and photographed breeding adult penguins at Gough Island and took measurements of 10 pairs of breeding birds. Their head plumes, underwing pattern and facial colouration were compared with photographs of Rockhopper Penguins at Tristan. They were similar in all respects. Culmen and flipper lengths of breeding adults from Gough Island and elsewhere are compared in Table I. Unfortunately there are no comparable data from Tristan. It is apparent from Table I that Rockhopper Penguins at Gough Island are similar in size to those at Amsterdam Island where the race concerned is *E. c. moseleyi* and that both these populations consist of individuals whose appendages are longer than those of nominate *chrysocome*. I infer from these comparisons that the Gough Island population of Rockhopper Penguins belongs to the race *moseleyi* and that they are not separable from the penguins at Tristan.

TABLE 1
Length (mm) of the culmen and flipper of adult Rockhopper Penguins
Eudyptes chrysocome.¹

Locality and reference	CULMEN LENGTH				FLIPPER LENGTH ²	
	N	♂♂ Mean ± SD	N	♀♀ Mean ± SD	♂♂ Mean ± SD	♀♀ Mean ± SD
Gough I. ³ (Author)	10	49.1 ± 3.8 (42.7 — 53.8)	10	43.6 ± 1.6 (41.2 — 46.5)	185.0 ± 4.7 (176 — 190)	179.4 ± 4.3 (174 — 186)
Amsterdam I. (Duroselle & Tollu 1977)	75	49.1	73	43.8	189.2	183.3
Marion I. (Author)	5	45.7 ± 1.5	6	40.6 ± 1.7	165.3 ± 7.5	161.5 ± 5.6
Campbell I. (Warham 1972)	10	46.4 ± 1.4	10	41.1 ± 2.1	167. ± 4.4	167. ± 3.4

¹Other parameters measured at Gough Island but for which insufficient comparable data are available are:

Culmen depth (mm), measured at point where the mandibular rami meet (Warham 1972), 10 ♂♂ 20.2 ± 0.9 (18.7 — 21.4) 10 ♀♀ 17.6 ± 0.8 (16.1 — 18.7); Foot length (mm) 10 ♂♂ 115.9 ± 3.2 (112 — 122) 10 ♀♀ 110.1 ± 4.3 (101 — 116).

²Sample size as for culmen length.

³Range in parentheses.

POPULATION SIZE

Comer (Verrill 1895) remarked that the penguins at Gough Island numbered "millions" and Swales (1965) considered that "probably two million breed". I sailed around Gough Island in the crayfishing vessel *Hilary* on 31 October 1979. During the 7-hour voyage I scanned the coastline with binoculars and estimated the populations of penguins in units of 100, recording the number of units by mechanical tally counter. The coastline of Gough Island, approximately 40 km long, consists primarily of very steep, vegetated slopes which limit the penguins to a narrow coastal fringe except at two localities on the east coast, The Glen and Sophora Glen, where penguins breed inland and could not be counted from the sea. Swales (1965) estimated the breeding populations at these two glens to be 1000 and 10,000

TABLE 2

Population size of Rockhopper *Eudyptes chrysocome* at Gough Island by coastal sector

Coastline sector	Estimated numbers of pairs
Transvaal Cove to South West Point	8,400
South West Point to Gaggins Point	4,900
Gaggins Point to North Point	15,700
North Point to North East Point	32,700
North East Point to The Glen	16,600
The Glen & Sophora Glen	(11,000) ¹
The Glen to Transvaal Cove	none visible
	from sea 89,300

¹data from Swales (1965)

pairs respectively. My own estimate for the remainder of the island totalled 78,300 birds (Table 2). At the time of my estimate almost all the birds ashore were males undertaking the last incubation shift and the estimate therefore gives a good indication of the number of breeding pairs at the island. Ground-truthing was not possible because the number of readily accessible areas adjacent to the weather station, where I was based on the island, contained few penguins and these were counted when the boat was closer inshore than at other sectors of the coast. Nevertheless, I consider that my

estimate had an error of no more than $\pm 33\%$, or for convenience, a total of 25,000 birds. On this basis, and using Swales' (1965) data for inland populations, I estimated the current breeding population of Rockhopper Penguins at Gough Island to be $90,000 \pm 25,000$ pairs.

This estimate, though vastly lower than the previous claims of millions, does not necessarily indicate a drastic reduction in the numbers of penguins at Gough Island. The steep slopes which confine the penguins to the coastal fringe also make it impossible to approach and census all the penguin colonies from the landward side. There is no evidence that Comer (Verrill 1895) or Swales (1965) made any concerted attempt to count penguins or indeed that they circumnavigated the island and their claims must be regarded as educated guesses. Swales (1965), also it should be noted, claimed that there were 200,000 pairs of Rockhopper Penguins at "Rookery Point", a locality which does not appear on his accompanying map. I have had extensive experience of counting penguins at other localities (Williams *et al.* 1979), and saw neither evidence for such a large colony nor an area which could accommodate a colony of this size. I think the previous estimates must have been such gross overestimates as a result of misjudging the size of suitable breeding habitat.

Warham (1975) considered that the race *moseleyi* was confined to four localities: the Tristan da Cunha islands, and St. Paul, Amsterdam and Gough Islands. The Rockhopper Penguin populations at each of these localities have now been estimated - Tristan 280,000 pairs (Elliott 1957); Amsterdam Island 100,000 pairs (Segonzac 1972); St. Paul Island 10,000 pairs (Segonzac 1972) - so that with Gough Island's 90,000 pairs, the world population for this subspecies is about 480,000 pairs, of which some 20% breed at Gough Island.

CLUTCH SIZE AND DIMENSIONS

Rockhopper Penguins, like all *Eudyptes* penguins, lay a clutch of 2 eggs which are dimorphic, the first laid or A-egg being markedly smaller and lighter than the second laid or B-egg (Warham 1975). There have been several reports that 3-egg clutches are laid at Tristan (e.g. Murphy 1936, Elliott 1957) and Watson (1975) has, apparently by extrapolation, stated that this is also the case at Gough Island. The reports of 3-egg clutches are not fully authenticated and are probably erroneous (Williams in press, a). Investigation of Rockhopper Penguin clutches at Gough Island by Shaughnessy (Shaughnessy & Fairall 1976), Voisin (1979) and myself have all failed to find any 3-egg clutches.

TABLE 3
Dimensions (mm) of Rockhopper Penguin *Eudyptes chrysocome* eggs

Locality and reference	LENGTH				BREADTH			
	A-egg		B-egg		A-egg		B-egg	
	N	Mean \pm SD	N	Mean \pm SD	N	Mean \pm SD	N	Mean \pm SD
Gough I. ¹ (Author)	30	65.2 \pm 4.0 (51.4—70.8)	30	73.0 \pm 2.6 (67.3—76.8)	30	49.2 \pm 1.8 (45.5—52.8)	30	55.2 \pm 1.7 (52.6—58.5)
Amsterdam I. (Duroselle & Tollu 1977)	44	63.2	44	70.1	44	49.7	44	54.7
Marion I. (Author)	122	62.3 \pm 2.6	119	70.2 \pm 2.6	122	46.8 \pm 1.7	119	52.9 \pm 1.7
Heard I. (Gwynn 1953)	11	63.9 \pm 2.7	11	71.9 \pm 2.0	11	46.4 \pm 2.9	11	52.9 \pm 2.5

¹Gough Island range in parentheses.

I measured the eggs in 30 2-egg clutches at Gough Island and these data are compared with data from other localities in Table 3. Both A- and B-eggs at Gough Island are on average longer and broader than eggs elsewhere (excepting the breadth of A-eggs at Amsterdam Island); but the degree of dimorphism between A- and B-eggs at Gough Island, calculated by Warham's (1975) method, is similar to that at other localities.

BREEDING SEASON

Comer (Verrill 1895) reported finding the first Rockhopper Penguin eggs at Gough Island on 14 September and that egg-laying was completed by 29 September. Swales (1965) reported that in 2 seasons the first eggs were found on 1 and 4 October. Newly hatched chicks have been recorded on 5 November (Shaughnessy & Fairall 1976) and 11 November (Swales 1965). During my visit, newly hatched chicks were found on 31 October, but most eggs did not hatch until 7-9 November. As the incubation period of the B-eggs of *Eudyptes* penguins (which produce most of the hatchlings) averages 35-57 days, the eggs at Gough Island during the last 20 years must have been laid in late September or early October, which is 2 weeks later than recorded by Comer in 1889. Since the time at which Rockhopper Penguins lay their eggs is related to sea temperature (Warham 1972), this suggests that there may have been some change in mean monthly sea temperatures between Comer's 1889 and Swales' 1955 visits. A similar delay in the breeding of Rockhopper Penguins has been recorded at Tristan (Elliott 1957).

MISCELLANEOUS OBSERVATIONS

At Marion Island (46°S, 37°E) only 41% of the Rockhopper Penguin nests which retain eggs until the end of the incubation period contain 2 eggs, and once the larger B-egg has hatched the remaining A-egg at these nests is ignored and fails to hatch (Williams in press, b). At Gough Island both eggs

TABLE 4
Contents of Rockhopper Penguin *Eudyptes chrysolome* nests at the end of the incubation period

Contents	Marion Island		Gough Island	
	%	(N)	%	(N)
A-egg only	6.3	(12)	10.4	(17)
B-egg only	52.9	(101)	23.9	(39)
A and B eggs ¹	40.8	(78)	65.7	(107)

¹Comparison of data in this line by χ^2 homogeneity (or contingency test gave a χ^2 value of 21.7.

were retained until the end of incubation (65%) at significantly more nests than at Marion Island (Table 4) and there seemed to be a higher proportion of nests at which 2 chicks hatched. Two factors are probably responsible for this situation: differences in the degree of predation and in nest-site ecology. The loss of eggs to predators is apparently more common at Marion than at Gough Island, because the penguin nest-sites at Marion Island tend to be less sheltered by rocks and vegetation than at Gough Island and also because the intensity of predation is probably greater at Marion Island than at Gough Island. Two predators, the Lesser Sheathbill *Chionis minor* and Subantarctic Skua *Catharacta antarctica lonnbergi*, prey upon Rockhopper Penguin eggs at Marion Island, whereas at Gough Island there is no predator of similar size to the Sheathbill, and the Subantarctic Skuas *C. a. hamiltoni* appear to prefer small petrels (Procellariidae, Hydrobatidae and

Pelecanoididae), which are more numerous there than at Marion Island, to penguin eggs.

Rockhopper Penguins incubate with their eggs placed one in front of the other, with the posterior egg situated between the parent's feet and thus less accessible to predators than the anterior egg (Burger & Williams 1979). The position of the eggs was recorded in 46 2-egg clutches at Gough Island. At two-thirds (31) the A-egg was in the anterior position. Some individual Subantarctic Skuas may specialise in preying upon penguin eggs and at one skua midden at Gough Island there were 30 eggs. Of 19 measurable eggs from this midden, 13 – approximately two-thirds – were A-eggs, a direct reflection of the normal placing of A-eggs in the anterior, more vulnerable incubation position.

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- Address:* A. J. Williams, FitzPatrick Institute, University of Cape Town, Rondebosch 7700 South Africa